January 5, 2011

Eric Tharp
DWP

Reference: High Pressure Turbine Retrofit Project

Dear Mr. Tharp:

Request for Information on Turbine Blade Stress at 950 MW

This letter is In response to a request from your office for information regarding turbine blade stresses at the target load of 950 MW. The final portion of this analysis was recently completed by Alstom Power, Inc. A copy of Alstoms recent analysis is attached for your review.

As noted in the DWP report 'Turbine/Generator Load and High-Pressure Heaters' dated October 24, 1990 (Project Modification 253) as well as all associated memos, the concern over turbine blade stress arises only when high pressure heater strings trip while the unit is in turbine-follow or manual modes. The units are essentially always operated in Megawatt Control where immediate valve response maintains unit load with negligible fluctuation.

The following supplemental information associated with blade stress analysis at the target design flow rate of 6.9MMlbs/hr is provided to ensure a comprehensive understanding of the attention given to this issue throughout the HP upgrade project. Analysis of turbine blade, partition and diaphragm loading associated with the scheduled 950MW uprate began well before an HP turbine section upgrade contract was signed. This issue has been addressed in several phases:

- Initial evaluation request to GE
- Initial evaluation request to Alstom
- Test verification of turbine operational parameters
- Final Alstom recommendations regarding heater out-of-service runbacks

Initial Evaluation Request to GE

Discussions with both potential bidders regarding blade loading during feedwater heater trips began in early November of 2000. The first documented response from GE on this subject occurred at 1:00pm on Thursday. December 21, 2000. At that time GE was responding to our request to analyze a worst case operating turbine blade stress scenario of a double, high pressure heater string trip with initial condition throttle flow at 6.9 MMlbs/hr. In that discussion, Mr. Joe Liesig, Mr. Larry French and Mr. Bill Kuehn confirmed that 6.9MMlbs/hr would not be a problem in the stated condition and that they were prepared to proceed with the bid process based on the 6.9MMlbs/hr design target.

A written statement confirming this conversation was requested from GE but never received. GE, however, submitted a full bid to provide the HP section upgrade based on the 6.9MMlbs/hr. (A copy of the bid evaluation detailing key parameters of the GE bid is attached.)

Initial Evaluation Request to Alstom

Alstom was also requested to provide an analysis regarding blade loading and stress at the target flow in early November of 2000. Alstom identified three concerns associated with increased throttle flow/stage pressures:

- Stress corrosion cracking at blade roots
- Heater shell design pressure limitations
- L-0 blade root stress

With discussion on IGS historical water quality, turbine overhaul NDE data and review of heater shell design pressure the first two concerns were shown to be very low priority. Outage visual and non-destructive testing has revealed no concerns at the blade roots or other locations susceptible to stress corrosion. Initial estimates for heater extraction pressures were well below heater shell design maximums.

Alstom stated that the weakest link in blade stresses occurred at the L-0 or last stage blading due primarily to changes in condenser pressure. Alstom presented the attached GE design document at that time covering LP exhaust flow limitations for a range of turbine sizes, including that at IGS. The attached email from Alstom dated November 10, 2000 shows the substantial margins remaining between operation and design on the L-0 blade root stresses at target conditions.

Test Verification of Turbine Operating Parameters

In a similar approach taken by DWP in the October 1990 report, Alstom based their recommendations for operational limits on the operational stage pressures recorded during valves-wide-open (VWO) operation. Accordingly, during the post-installation, performance testing actual flows and stage pressures associated with VWO and nominal full load target of 950MW were recorded and instituted as maximum allowable operating parameters in all modes of operation.

Throttle flows recorded at full load (950MW) were notably less than target due to higher

than guarantee HP section efficiency. As a result, throttle flow at 950MW was approximately equal to the IGS historical design limit of 6.6MMlbs/hr and stage pressures were within 2% of those used as the design limit established by DWP within the above noted report on turbine blade stresses.

Final Alstom recommendations regarding heater out-of-service runbacks

Alstom has recently issued their final recommendations on runbacks associated specifically with heaters out-of-service at the test verified flows and pressures. A copy of this document is attached. Of the original concerns, stress corrosion cracking is still considered to be a low level concern and heater shell pressures were verified to be well within the design maximum (see sheet 3 of Alstom analysis.) Flow induced blade stress at full load will also be incrementally less than anticipated due to reduced throttle flow at nominal full load, associated with the higher than guarantee HP section efficiency.

The attached Alstom analysis provides recommended runbacks associated with the VWO stage pressures for various combinations of high pressure heaters out-of service. These runbacks will be reflected in the IGS load guide sheet and submitted for your approval in the near future. You may contact James Nelson at (435) 864-6464 with questions regarding these analyses.

Sincerely,

George W. Cross
President and Chief Operations Officer

JHN:

From: James Nelson
To: phil.hennessy@power.alstom.com
Date: 6/6/01 7:14AM
Subject: Fwd: Additional Info from Intermountain Generating Station

Phil, My apologies for sending the wrong file to Steve Gale. I sure you were both thoroughly confused by mill fineness data. I must have attached the wrong file. I hope the attached file, which I have sent to Richard Plant and Phil Kearney will make more sense.

Regards
James

From: James Nelson
To: Aaron Nissen; Dave Spence; Garry Christensen; Jerry Hintze; Phong Do
Date: 6/7/01 7:16AM
Subject: Fwd: Re: A couple more issues from Intermountain

The attached email is confirms that Alstom realized that the data we provided 'owiginawy' was based on the 1967 steam tables as opposed to the contract referenced 1997 tables; and they made the appropriate adjustments.

From: Phong Do
To: James Nelson; Jon Christensen
Date: 3/1/02 10:12AM
Subject: Fwd: Re: Turbine-Generator SMF Relay Protection

Please review the attachment. Thanks.

CC: barry.ingle@power.alstom.com

From: <bill.eisma@power.alstom.com>
To: <jim-n@ipsc.com>
Date: 10/22/01 10:43AM
Subject: 1350030 Delta 1+2 - Flow vs Pressure Curve

James,
We attach for your information and records TS29367A which is a curve of HP stage 1 inlet pressure against throttle flow and is part of the thermal kit for Delta units 1+2.
Note this is stage 1 inlet pressure, not stage 1 exit pressure, because after the retrofit the units will be throttle control, not nozzle control.

Bill Eisma

(See attached file: ts29367a.pdf)

CC: <Phong-D@IPSC.com>

From: <bill.eisma@power.alstom.com>
To: <jim-n@ipsc.com>
Date: 4/27/01 9:44AM
Subject: 1350030. Delta 1+2 Preliminary Heat Balance

Dear Jim,

As requested by your Mr. David Spence on 4/18/01 we attach for information the heat balance TS 29247A for unit 2 when operating at 2400 psig/1000 degreeF/1000 degree F, valves wide open and a main steam flow of 6.9 Mlb/h.

Please note that is a preliminary issue for information only, the final balances will be submitted at a later date.

Sincerely,

Bill Eisma

From: James Nelson
To: lee.thornton@power.alstom.com; phil.hennesy@power.alstom.com; phil.kearney@power.alstom.com; richard.plant@power.alstom.com
Date: 6/5/01 2:42PM
Subject: Additional Info from Intermountain Generating Station

Richard,
Adrian asked that I send the valve pressure drop data directly to you as it became available. Would you please also check the addresses for Phil Hennesy (sp?) and others to make sure they received this data as well.

We completed pressure drop measurements across the U1 HP turbine stop and control valves yesterday afternoon. Measurements were taken at throttle valves wide open and design (2400 psig) throttle conditions. We measured pressure with our Heise PT-E1 pressure calibrator with a 0-3000 psi HQS-2 pressure sensor which has been calibrated to 0.05% full scale accuracy. Reported pressures have been compensated for sensor line water leg and throttle pressure variations between measurements.
Upstream pressures were measured at the main steam header lead test taps ahead of the stop and control valves. All pressures are psig.

dp from hdr lead #3 to turbine lead from CV 1D2 #4 (lead to bottom of turbine)
2393.2 - 2342.1 = 51.1 (-2.14%)

dp from hdr lead #4 to turbine lead from CV 1C2 #3 (lead to top of turbine north side)
2389.5 - 2342.3 = 47.2 (-1.98%)

The numbers shown above are the drops we would consider to be those applicable to the turbine design. These are also the taps we anticipate using within the HP section performance testing. In addition to these, for reference only, we also measured and calculated pressure drops from the main steam pressure control point (1COAXI012A) to the CV lead pressure taps. Note that the main steam pressure control tap is from the main steam line before it splits into the header leads.

dp from main steam pressure control point to turbine lead line from CV 1D2 #4
2405.3 -2345.6 = 59.7 (-2.48%)

dp from main steam pressure control point to turbine lead line from CV 1C2 #3
2394.6 - 2340.9 = 53.7 (-2.24%)

Also, for Phil Kearney and Bob Brown I just wanted to reiterate the following regarding our request for heat balance diagrams. We would request the following:
1. VWO,2400, 6.9Mlb/h (976) already received the preliminary for Unit 2
2. 100% load - 950 MW
3. 75% load - 712.5 MW
4. 50% load - 475 MW
5. 32% load - 300 MW

All of these HBD's at design throttle (2412.2 psia, 1000 deg) and reheat (1000 deg) conditions.

Also, the engineer that I have assigned to work directly with the installation coordination aspects for Unit 1 and 2 is Mr. Phong Do. Lee would you please confirm if you or Adrian recieved a sizeable stack of information from Phong recently. I failed to ask Adrian yesterday before he left on vacation.

Upon my visit to Rugby, Adrian was working to assemble a significant portion of the pages of

info that we discussed there. I received a few outline drawings of a G3 machine today which is of definite interest but am still looking forward to receiving the main body of info we reviewed during my visit. If Adrian didn't get a chance to send these pages before he left we my have to await his return.

Richard, Rob Cunningham and I discussed a couple ideas regarding how we might secure the existing rotot to the inner casing for removal. We are still discussing this idea here. We would appreciate any ideas from Alstom that might contribute to this discussion. I am aware that the utility in Missouri where Alstom recently replaced an HP section, just picked up the rotor and allowed the diaphragm packing to bear the weight of the inner casing. How legitimate does Alstom consider this approach? How about welding a bracket to the casing?

You may contact me at jim-n@ipsc.com .
Regards
James Nelson

CC: Aaron Nissen; Dave Spence; Phong Do